

ABSTRACT OF THE DISCLOSURE

Apparatus and methods are directed to producing consistent bond-zone consolidation quality during additive manufacturing processes, even under constantly changing joining conditions, and regardless of location within the part being built. Various alternative techniques are disclosed involving the energy delivery to the bond zone, stiffness and mechanical resistance to vibration in the bond zone, and thermal conditions in the bond zone. These methods can be used independently or in combination, using a variety of control schemes, hierarchical or parallel. Also, although the examples generally employ a tape-type feedstock, these teachings apply equally well to sheet, tape, filament, dot type, and other feedstock geometries. In addition, although the invention is described in terms of Ultrasonic Object Consolidation (UOC), the disclosed apparatus and methods apply equally well to electrical resistance and frictional consolidation processes through appropriate engineering modification.